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EVALUATION OF APPLICATION OF ECO FRIENDLY SYSTEMS IN BUILDINGS IN NIGERIA

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ABSTRACT

The study evaluated the application of eco-friendly systems in some selected buildings in Nigeria with a aim of taking advantage of natural resources for building efficiency. Qualitative and Quantitative research methods were employed in this study. Data was obtained by the administration of questionnaires to occupants of residential buildings and the designs of their building were also assessed against sustainable standards. Findings showed that the buildings of sampled respondents were not sustainable and the natural resources available in the environment were not properly utilized. In addition, the residents pay more for energy consumption because the natural resources in the environment were not adequately integrated in the building. The study therefore recommended that a green building rating system like the Leadership in Energy and Environmental Design (LEED) suitable for Nigeria should be designed to guide new projects and renovations.

Keywords: Eco Friendly, Green Buildings, Sustainability, Day Lighting, Ventilation, Heating, Integrated Design:

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1. INTRODUCTION

The building industry contributes a great percentage of environmental degradation as it seeks to provide services such as lighting, water and climate control for needed shelter, economic profit and human comfort. Buildings are associated with various systems such as ventilating, cooling, day lighting and heating systems among others. The adverse contributions of these systems are pioneered by Conventional technologies in form of mechanical and electrical

systems used to power and enhance their required functions. In addition to the emission of these gases, solid and water waste are also generated which also pollute the environment throughout their life cycles. This will have enormous impacts on nature. Solid and water waste could be linked to poor building design or materials used. The rate of environmental degradation has called for a need for the industry to take direct responsibility of the sustenance and protection of its environment. climate change [1] warns of threats to the survival of humanity from changes to the climatic environment, where global warming is no longer a far off problem, but requires our awareness as a serious threat today, not just at a national or regional level, but as a global response. Among the global responses made are the Energy star ratings and the Green Building Council. Leadership in Energy and Environmental Design's (LEED) Green Building Rating System is a nationally accepted standard for measuring the effectiveness of green strategies used in buildings. It was developed by the United States Green Building Council (USGBC) in 1999; LEED promotes a whole-building approach to sustainability by recognizing performance in several areas of human and environmental health which is also appropriate for Nigeria as it offers a lot of benefits in terms of economic, social and technological contributions, [2]. Eco friendly systems functions efficiently using sustainable resources while creating a healthier and more energy-efficient home. Several renewable energy resources which include the Sun light rays, wind and water prevailing in an environment are fully explored to save energy, reduce or if possible eliminate the use of mechanical and electrical systems to provide for ventilation, day lighting, heating, cooling etc. an integrated design method is employed to ensure that best design considerations are implemented. These sustainable resources limit the use of non renewable forms of energy existing in the ecosystem. Nigeria has not sufficiently paid enough attention to the various sustainable practices available to her. Green building when used in Nigeria preserves and restores vital ecosystem necessary for sustaining life and becoming a net producer and exporter of resources, materials, energy and water rather than being a net consumer. Sustainability in the construction industry increases economic satisfaction; building utility, durability and provides comfort in its entire cycle.

In recent years we have seen and experienced high level of degradation of the environment. Long existing structures produce some harmful substances that have adverse impact on health and our environments. There is a need in the retrofitting of existing structure and to create an awareness of some basic operations to minimize the adverse contributions of old systems and to recycle some of the wastes products from such buildings.

Sustainable resources that make up the green buildings are vast in its utility but may be underutilized when not properly planned and designed for. Many times building projects are executed without careful decision on the relevant sustainable systems to be integrated in the building. Where natural resources such as the energy and natural lighting from the sun, water from rain and fresh air from wind are found there should be effective ways to harness these natural resources in the building system to ensure that lighting, ventilation and cooling heating and energy supply needs are considerably satisfied rather than relying on mechanized systems to service the building which may be of adverse effects at the long run [3].

Furthermore there is a high rise in the cost of housing in Nigeria resulting from several factors which include the cost of conventional building materials, cost of building and maintaining mechanized systems for energy supply. Rising medical bills due to health challenges as result of poor indoor air quality and pollution can also be associated with the absence of eco-friendly application in building systems in a developing country like Nigeria. The study aimed to examine the application of eco-friendly systems in buildings in Nigeria.

2. REVIEW OF RELATED STUDIES

2.1. Environmental friendly energy efficient Buildings

The contribution of green buildings cannot be neglected in various developing countries of the world. Sustainable buildings are seen to have contributed to the economy of a nation. These buildings in contradiction to the believe that they are more expensive, probably may not cost more and provides economic benefit to individuals, businesses, communities, governments and nations. To reduce energy consumption and also to save cost. [4] mentioned in the x-ray of the available choices of technologies to be adopted; is the use of renewable energy resources and building environmental friendly energy efficient houses. Prior to inception of the building project, experts in eco-friendly constructions are called upon and a critical planning is set in motion. This planning ensures that all necessary construction procedures to achieve Energy Star ratings are practiced and various potential renewable energy sources are fully tapped. The sun is used to generate photovoltaic energy to power appliances which are utilized for home user's daily comfort. Energy from the sun can also be used for heating spaces and water, a heating system is used which stores energy and uses it when the need arises. Day lighting benefits are explored which makes the use of artificial lighting minimal through the use of properly placed windows and skylights.

Indoor environmental quality of buildings in Nigeria would be greatly improved; buildings would be appropriately located and proper ventilation would be employed. Good ventilation reduces the occurrence of respiratory diseases and allergies, [5]. The improved indoor environmental quality will certainly improve health and living standards of the country. Good eco-friendly designs offers environmental benefits, runoff water from rain for example can be collected in storage reservoirs or tanks and is treated and used for domestic activities. Furthermore liquid waste from bath, sink etc can be recycled and used for flushing cisterns, these are practices used to prevent water pollution in the environment.

2.2. Advantages of practice of eco-friendly systems

The practice of eco-friendly systems application will lead to increased job creation in the economy. Various skills in design, engineering, management, manufacturing etc will be relevant in the execution of eco-friendly projects, for example the use of integrated photovoltaic solar power systems (PV) increases manufacturing of this technology and reduces reliance on fossil fuels. Installation of PV requires special skills that are a part of the eco-friendly economy. These modern buildings require trained personnel who can design, install, operate and maintain the emerging technologies. Lack of Job opportunities has been a problem in the Nigerian economy the eco-friendly technology would make possible the training and utilization of the idle bright minds the country has.

As Eco friendly building methods are practiced and cutting edge technologies are built. They could make up a tourist center, vacation and excursion facilities etc which are major sources of generating revenue as practiced in developing counties like Dubai. Furthermore, awareness would be created for people to know and learn about eco-friendly systems and it may also influence decisions above conventional residential, industrial or commercial property investment because the green real estate market is still small, people are even willing to move great distances to get into an eco-friendly built community or to find just the right home or facility.

Principles of eco-friendly buildings ensure that land properties are judiciously utilized and also seek to eliminate every practice that has adverse effect on the ecosystem. Energy efficiency is optimized by the use of renewable sources of energy. This was further supported by [6] and cited by [7] who added that sustainable buildings will contribute positively to a better quality of life, work efficiency and a healthy working environment.

[8] identified the benefits of eco-friendly buildings as the following: reduction in fossil fuel emission when electricity is produced, minimization of pollution and less demand on non-renewable resources, reduction in energy consumption and cost, provision of thermal insulation and comfort and finally to reduce adverse environmental impact.

3. RESEARCH METHODS

Residential staff quarters buildings in Covenant University Ota, Ogun State was selected as a case study to observe the current application of eco-friendly systems in Nigeria. Buildings are 192 square meters, 4 Bedroom Duplex, made of Sandcrete hollow block; Finishes: 25mm rendering texcote painted. The windows are: Material: Aluminum framed with 15mm tick transparent glass. Door Materias are l: Interior door: polished hard wood framed Mahogany solid core paneled door. Exterior: Ionized double swing security door with metal frame. Roof: Material: 0.45mmthick long span aluminum roofing sheets. Floor: Material: 25mm floor screed on 150mm over site concrete.

Finishes: floor tiles in Main lounge, dining, kitchen and bedrooms vitrified floor tiles in toilets and bathrooms This research study is based on field survey, use of structured questionnaires.[9],[10],[11],[12] Primary data were obtained through structured questionnaires to the residents in the Professors buildings . Secondary data was obtained from books, journals, reports, publications and the internet. The 5-likert scale was used. The data from the questionnaire was analyzed using SPSS. The method of presentation was pictorially done via frequency distribution and percentages, histograms, graphs, tables and charts.

4. DATA ANALYSIS AND PRESENTATION

4.1. Sex Distribution of Respondents in Covenant University Professors Residential buildings

66.7 % of the 15 respondents were males, while 33.3% of the respondents were females. This infers that a larger percentage of the respondents who were administered questionnaires for the identification of eco-friendly systems and the assessment of existing building design were males

4.2. Age Distribution of Respondents

53.3% respondents were above 60 years, 26.7% were between the ages of 40 and 60, while 20% were between the ages of 20 and 40. By implication more respondents who were actually the Professors are above 60 years.

4.3. Identifying Eco Friendly Systems in Buildings

Using Relative Awareness Index $R.A.I = \frac{4(EA)+3(MA)+2(SA)+(NA)}{4(EA+MA+SA+NA)}$

EA-Extremely aware **MA**-Moderately aware **SA**-Slightly aware **NA**- Not at all aware

Table 1 Level of Awareness of eco-friendly systems in buildings by respondents

Eco friendly	Awareness	RAI	Rank
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systems	NA	SA	MA	EA		
Energy Star Bulbs	2 [6.7%]	6 [20.0%]	4 [13.3%]	18 [60%]	0.82	1
Inverter	4 [13.3%]	4 [13.3%]	8 [26.7%]	14 [46.7%]	0.77	2
Solar Panel	4 [13.3%]	4 [13.3%]	8 [26.7%]	14 [46.7%]	0.77	2
Double glazed window	4 [13.3%]	8 [26.7%]	4 [13.3%]	14 [46.7%]	0.73	3
Energy Star Air conditioner	6 [20.0%]	4 [13.3%]	8 [26.7%]	12 [40.0%]	0.72	4
Gas water heater	6 [20.0%]	6 [20.0%]	4 [13.3%]	14 [46.7%]	0.71	5
Solar water heater	8 [26.7%]	4 [13.3%]	8 [26.7%]	10 [33.3%]	0.67	6
Skylight/atriums	8 [26.7%]	6 [20.0%]	4 [13.3%]	12 [40.0%]	0.67	6
Storm/Rain water harvesting system	8 [26.7%]	14 [46.7%]	8 [26.7%]	10 [33.3%]	0.67	6
Solar water pump	6 [20.0%]	12 [40.0%]	0 [0.0%]	12 [40.0%]	0.65	7
Solar window	10 [33.3%]	4 [13.3%]	6 [20.0%]	10 [33.3%]	0.63	8
Solar roof tile	17 [46.7%]	6 [20.0%]	2 [6.7%]	10 [33.3%]	0.57	9
Grey water system	14 [46.7%]	4 [13.3%]	8 [26.7%]	4 [13.3%]	0.52	10

Table 2 showed that the 1st most aware system is energy savers, ranked 2nd is solar panels and inverters. Ranked in 8th, 9th and 10th were the systems that respondents were less aware namely solar windows, solar tile and grey water system respectively. The respondents affirmed that most of these systems were not integrated or in use in the building and so may be responsible for their less awareness of the systems.

4.4. Assessment of Existing Building Design

4.4.1. Energy Efficiency

Fig 1 shows that a greater percentage of the respondent indicated their satisfaction of the building's orientation by indicating that the rooms and the building in general were very good in terms of ventilation and day lighting.

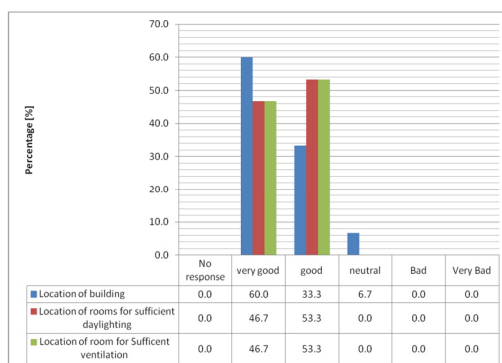


Figure 1 Response on the satisfaction of building Orientation by the residents

Some others indicated that the building orientation was good and the remaining few were neutral about it. No respondent indicated that the building orientation was neither bad nor

very bad. This result shows that the building orientation is good. It should be noted that respondents argued that their building satisfaction were based on what was obtainable in the public areas of the state, so therefore basing their satisfaction from the point of being advantaged.

Fig 2 shows that majority of the respondents use the mixed cooling system of ceiling fan and natural ventilation very often to maintain a certain level of temperature in the building. 40% and 33.3% of the respondents use mixed cooling system often,

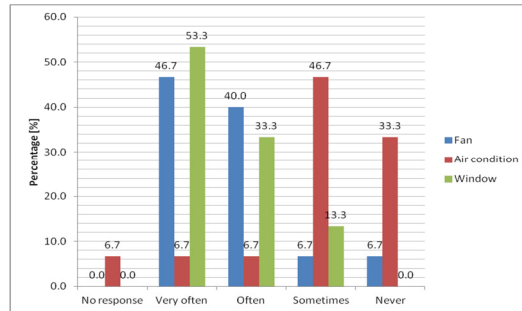


Figure 2 Response on how often respondents use cooling systems in building

46.7% of the respondents wish to use the air conditioning system but only have the privilege of using it sometimes because of its effect on outrageous electricity consumption as described by some respondents. The frequent need for cooling load could be traced to a poor building orientation [13]

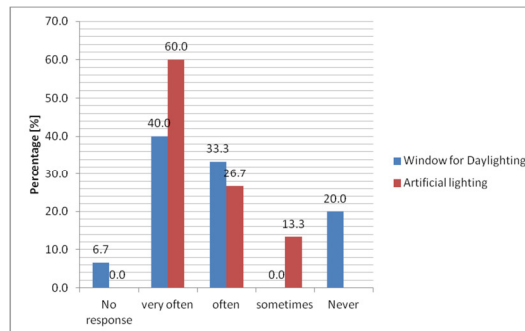


Figure 3 Response on how often respondent use systems for lighting

Fig 3 shows that majority of respondents need to turn on their artificial lighting systems very often to compliment the day lighting in the building. This implies that lighting of the building has relative effect on the energy consumption.

Response on the satisfaction of Electricity rate

No respondent was satisfied with the electricity rate, 20% percent were satisfied, 6.7% were neutral and 73.3% of the respondents were dissatisfied with electricity rates that show the consumption pattern of the buildings and further justifies why the respondents could not use the air conditioning system even when needed.

4.4.2. Water Efficiency

Fig 4 shows the Respondents response on water satisfaction, majority of the respondent revealed that water was provided by the University and they were satisfied with the services.

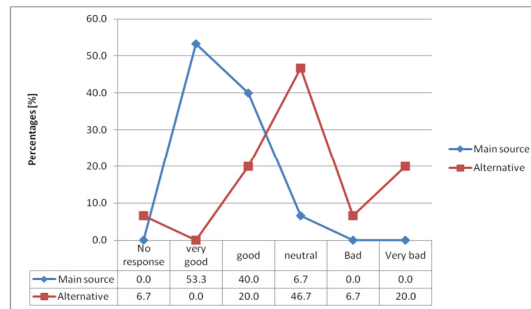


Figure 4 Response on water satisfaction by respondents

Water consumption measures were not taken to reduce water consumption in buildings and by observation; water for irrigation practices came from portable water sources other than the suitable systems that utilize recycled water or rain water as encouraged by the sustainable code.

4.3.3. Environmental Protection

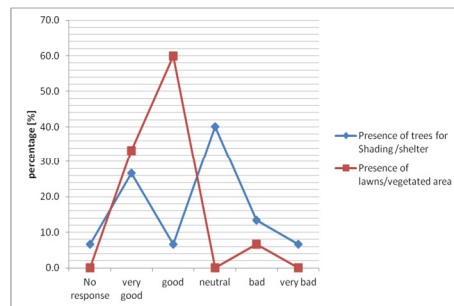


Figure 5 Response on the satisfaction of greenery practice

Fig.5 shows that majority of the respondents feel that the presence of lawns and vegetated area around the building was good. Also Majority of the respondents were neutral about how satisfied they were on the presence of trees for shading and shelter. The practice of greenery reduces the heat island effect around the peoples which was satisfactorily practiced in the University but by observation more trees should be planted to compliment the beautiful lawns.

Table 2 Response on satisfaction of building materials by respondents

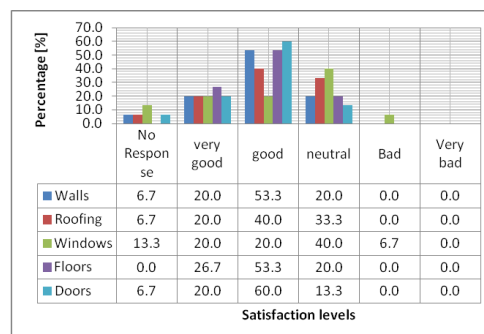


Table. 2 shows that materials used for the building are relatively good. The sustainable code encourages the adoption of building designs, Construction practices and materials that are environmentally friendly and sustainable. The use of Eco friendly materials among other things reduces the high embodied energy used in the production of materials.

4.3.4. Indoor Environmental quality

More than 60% of the residents were satisfied with the day lighting of the buildings. This has an impact of the overall indoor environmental quality of the buildings.

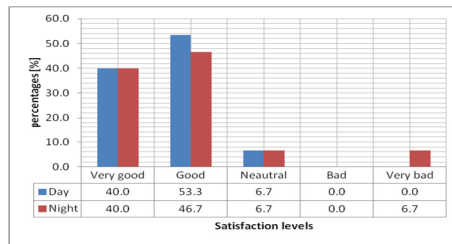


Figure 6 Response on natural ventilation at Day and Night time

Fig 6 shows that more than 50% of the residents were satisfied with the ventilation during the day and at night in the building. This has an impact of the overall indoor environmental quality of the building.

Response on Indoor Air Quality

Majority of the respondents said that natural ventilation and day lighting is satisfactory. The adequacy of these factors makes up the indoor air quality in a building especially in the kitchen, bathrooms and toilet as encouraged by the sustainable code.

4.3.5. Other Green Features

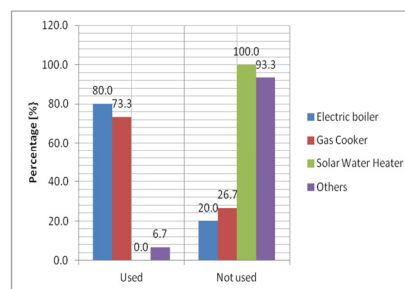


Figure 7 A chart showing the dependence on non-renewable conventional energy system than renewable System for boiling water.

Fig. 7 shows that 80% of the respondent used electric boilers to boil water, 73.3% also used gas cooker to boiler water. The research shows that all of the respondents do not use solar heating system in building because it wasn't integrated in the building. This would invariably minimize the energy consumption by boilers in the building. Also, 93.3% of the respondent revealed that there was no green feature like solar panel, Inverter, solar water heater etc in the building. The sustainable code encourages the use of other green features which are innovative and have positive environmental impact and reduces load of consumption cost in the building.

5. CONCLUSION AND RECOMMENDATION

The integration of natural resources in building design will help to maximize building energy efficiency especially when proper building orientation is done. The right placement of windows in design can be done by determining the position of the sun relative to the building in the proposed site

There should be awareness on Eco friendly buildings and the benefits especially on how well it helps to minimize energy consumption should be carried out in the University. A green building rating system like the Leadership in Energy and Environmental Design (LEED)

suitable for Nigeria should be designed to guide new projects and renovations on aspects that must be considered and implemented to earn points for green certification in Nigeria.

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